International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 9, Issue 3, Jun 2019, 13-22




# MEASURING PRODUCTIVITY INDEX WITH OBJECTIVE MATRIX (OMAX) METHOD IN THE DIECASTING ALUMINUM INDUSTRY

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***ABSTRACT***

***Productivity in the manufacturing industry has a very important role, the manufacturing industry must have good productivity, this aims to improve the quality of the company and also increase profits for the company. The diecasting aluminum industry is one of the industries that have a high level of complexity ranging from high defective products, the mold was an overshoot, frequently changing production plans and high employee absence rates. But, the diecasting aluminum industry has the advantage that defective products can be re-melted as raw material. Every company must be able to know the factors that cause low productivity and the first step that must be done is to measure productivity itself, to measure productivity can be done using the Objective Matrix (OMAX) method after the level of productivity is known then looking for factors that cause low productivity, the factors causing low productivity are carried out by the method of Traffic Light System (TLS). The standard productivity index value on the OMAX method is 300, where this value is at the level of score 3. For the Traffic Light System method, the color indicator is green, yellow, and red. For factors that cause low productivity are given a red color with score levels ranging from level 0 to level 2 in the OMAX table. During 2017, there were three months, which had a value of productivity below the standard, namely in June (-0.02), November (-0.35), and December (-063) and the main factors that cause low productivity are high employee absence rates, and also high machine downtime.***

***KEYWORDS:Productivity, Objective Matrix (OMAX), Traffic Light System (TLS)& Management Control***

**Received:**Feb 15, 2019; **Accepted:**Mar 11, 2019; **Published:**Apr 06, 2019; **Paper Id.:** IJMPERDJUN20192

Original Article

## INTRODUCTION

The manufacturing industry is an industry that continues to grow and develop both from the technology used or methods in the production process. The manufacturing industry is an industry that processes raw materials into finished materials or semi-finished materials, in order to win the very tight industrial competition, a method is needed in an effective production process, in addition to using the right technology in the production process. The diecasting aluminum industry is an industry that has an important role in the automotive industry, because many parts used in assembling two-wheeled vehicles and four-wheeled vehicles use aluminum parts. As we know, the growth of the automotive industry continues to increase every year, as the demand for motorized vehicles, both two-wheeled and four-wheeled vehicles increases, therefore the diecasting aluminum industry must have high productivity and be efficient in the use of resources to increase competitiveness.

In the manufacturing industry, a continuous increase in productivity is urgently needed, it aims to keep the condition of the company in good condition, in principle productivity has four cycles, that is :

- Measurement
- Evaluation
- Planning
- Increase

Productivity is a combination of effectiveness and efficiency, productivity has a relationship with the results obtained, while efficiency has a relationship with the resources used. Manufacturing industries that maintain productivity will make the company perform well and the resulting profits can be maximized. Factors that cause low productivity must be identified, so that they can be avoided and can be found the best solution so that, the factors that cause low productivity are not repeated in the future. To find out the first low productivity factor that needs to be done is, to measure the productivity index first. One method that can be used to measure productivity index is by using the Objective Matrix (OMAX) method. There are three important aspects of measuring productivity by using OMAX, that is :

- **Awareness**

  Understand productivity problems, the possibility of increasing productivity, able to increase productivity

- **Increase**

  Know how to do it, able and willing to carry out repairs

- **Maintenance**

  Retain achievement, maintain the spirit of progress

The traffic light system (TLS) method is closely related to the scoring system, TLS serves as an indicator of whether the criteria need improvement or not, TLS displays in the form of a color indicator, where the colors have the following meanings:

- Green, means that the achievement of an indicator of performance has been achieved.
- Yellow, means that the achievement of a target performance indicator has not been achieved even though the indicator value is nearing the target.
- Red, means that the achievement of an indicator value is below the target and requires immediate improvement

## STUDY LITERATURE

Sukendar Irwan et.al (2017) discussed the use of Analytical Hierarchy Process (AHP) and Objective Matrix (OMAX) in measuring supply chain performance. And, to determine which suppliers are below the standard, Traffic Light System is used so that, suppliers are found to have performance that is below the target., NurwantaraPambudiet.al (2018) this study aimed to determine the level of total, and also partial productivity using the Objective Matrix (OMAX) method and propose a lack of improvement in productivity., MouzaniImane Aland BouamiDriss(2019) in their study applied the lean maintenance concept, where this concept was derived from the application of toyota production systems which discussed improving performance in terms of engine maintenance, so that maintenance could be performed optimally., Shantideo Gujar et.al (2018) discusses the problem of increasing productivity in the manufacturing industry, where

productivity increases are carried out using equipment and work techniques that can increase efficiency, so that productivity can eventually increase., YosanR Baguset al. (Proceeding of the 9th International Seminar on Industrial Engineering and Management), in their study discusses the increase in labor productivity, where the data used by output productivity is compared to inputs in the building management work process, which are then calculated using the Objective Matrix method (OMAX), where it is known that low productivity is caused by the use of work methods and inadequate allocation of labor, and after improvements, productivity increase 20% of each measurement ratio., Pharne and Kande (2016), this researchdiscuss the maintenance score card (MSC) in private companies, where performance indicators are used to measure performance and to improve the action plan. In this study, AHP used to determine the top priority, and to conduct performance measurements, the Objective Matrix (OMAX) method was used.

## METHODOLOGY

This research was conducted in many stages, the method used to measure productivity using Objective Matrix and to find out the factors that cause low productivity using Traffic Light System methods. The first stage of this research is to determine the problem of what will be studied, then identify the problem and collect the data needed in this study. The data used consists of two types, namely primary data and secondary data. From the data, we get the next stage determines the criteria that want to know the level of productivity, from the data we could calculate the value of the ratio according to the criteria that have been set.

After getting the ratio value from each of the following criteria, determined the upper control limit, standard value, and lower control limit. To fill in the values at each level of the OMAX table, we specify the interval value, according to the level where the interval value level is divided into two parts, namely the interval value level 0 to 3, and the interval value level 3 to level 10. The next stage calculates the weight value of each criterion using the Analytic Hierarchy Process (AHP), after all the value variables we have obtained, the next step is to calculate the performance index by using the OMAX table, by getting a performance index value, we can calculate its productivity index. The last step is looking for criteria that cause low productivity by using the Traffic Light System (TLS).

## RESULTS

### Determining Measurement Criteria

In this study, the productivity measurement criteria were used as many as 6 criteria, it's :

- Minimization of defective products.
- The efficiency of working hours.
- Efficient electricity usage.
- Optimization of production plans.
- Optimization of production machinery.
- The effectiveness of employee attendance

Data needed to calculate ratios according to the criteria mentioned above are as follows.

**Table 1: Criteria Data**

| Month | Total Check | Product Defect | Production Plan | Production Actual | Electic (Kwh) | Working Hour (Hour) | Machine Working Hour (Hour) | *Downtime* (Hour) | Absent (Days) |
|---|---|---|---|---|---|---|---|---|---|
| January | 509370 | 23700 | 653606 | 595318 | 97760 | 1620 | 3186 | 385 | 28 |
| February | 577009 | 29861 | 901975 | 699797 | 101456 | 1600 | 3616 | 366 | 15 |
| March | 658845 | 31406 | 844915 | 732463 | 122672 | 1740 | 4717 | 699 | 26 |
| April | 609558 | 47702 | 917480 | 706417 | 113664 | 1510 | 4464 | 675 | 10 |
| May | 834537 | 46679 | 999217 | 735964 | 118400 | 1600 | 4714 | 832 | 22 |
| June | 569162 | 34078 | 661961 | 462690 | 83248 | 1200 | 3532 | 562 | 22 |
| July | 790957 | 48282 | 965840 | 721653 | 120848 | 1670 | 4579 | 670 | 9 |
| August | 1014729 | 76054 | 1103921 | 879614 | 123376 | 1740 | 4719 | 537 | 16 |
| September | 1014729 | 65347 | 1001332 | 799085 | 105640 | 1580 | 3951 | 409 | 26 |
| October | 1043383 | 69278 | 990136 | 733435 | 103208 | 1740 | 4057 | 710 | 23 |
| November | 1076861 | 90859 | 804783 | 626323 | 98560 | 1740 | 3510 | 415 | 31 |
| December | 681791 | 76725 | 526996 | 415611 | 68320 | 1510 | 2133 | 247 | 104 |

## Calculating Value Ratio

Calculate the ratio of the criteria used with the following formula:

**Ratio 1:**Minimization of defective products $= \frac{\text{product defect}}{\text{total check}}$

**Ratio 2:**Efficiency of working hours $= \frac{\text{Production actual}}{\text{working hour}}$

**Ratio 3:**Efficient electricity usage $= \frac{\text{production actual}}{\text{electricity consumption}}$

**Ratio 4:**Optimization of production plans $= \frac{\text{production actual}}{\text{production plan}}$

**Ratio 5:**Optimization of production machinery $= \frac{\text{machine working hour}}{\text{downtime}}$

**Ratio 6:**Effectiveness of employee attendance $= \frac{\text{working days}}{\text{absent}}$

For the ratio 1 period January to December, we can look in table 2:

**Table 2: Value Ratio 1**

| Month | Product Defect | Total Check | Ratio 1 |
|---|---|---|---|
| January | 23700 | 509370 | 0,047 |
| February | 29861 | 577009 | 0,052 |
| March | 31406 | 658845 | 0,048 |
| April | 47702 | 609558 | 0,078 |
| May | 46679 | 834537 | 0,056 |
| June | 34078 | 569162 | 0,060 |
| July | 48282 | 790957 | 0,061 |
| August | 76054 | 1014729 | 0,075 |
| September | 65347 | 1014729 | 0,064 |
| Ocotober | 69278 | 1043383 | 0,066 |
| November | 90859 | 1076861 | 0,084 |
| December | 76725 | 681791 | 0,113 |
| Standard values | | | 0,067 |
| Lowest value | | | 0,113 |

**Determining Standard Value, Upper Control Limit, and Lower Control Limit Value**

To determine the standard value, the upper control limit value, and the lower control limit value we calculate using the equation like this :

$$UCl = \mu + k.\sigma$$

$$DA = \frac{\sigma}{\mu} x\ 100$$

$$cl = 100\% - DA$$

UCL = Upper control limit

DA = Degree of accuracy

CL = Confident level

k = Constanta

= 1, if0% ≤ CL ≤ 68%

= 2, if 68% < CL ≤ 96%

= 3, if 95% < CL ≤ 99,7%

Ratio 1

$\sigma = 0{,}0186\ and \mu = 0{,}067$

$$DA = \frac{\sigma}{\mu} x\ 100$$

DA = (0,0186/0,067) x 100 = 0,278

CL = 100% - DA = 0,722

$$UCl = \mu + k.\sigma$$

= 0,067 + 2. 0,0186 = 0,104

$\mu = \frac{1}{12}\sum_{i=1}^{12}$ = 0,067

$$LCl = \mu - k.\sigma$$

= 0,067 – 2. 0,0186 = 0,030

**Table 3: UCLValue, Standard Value, and LCLValue**

| | Ratio 2 | Ratio 3 | Ratio 4 | Ratio 5 | Ratio 6 |
|---|---|---|---|---|---|
| UCL | 551,381 | 7,631 | 0,899 | 10,613 | 62.540 |
| $\mu$ | 419,942 | 6,430 | 0,784 | 7,630 | 39,353 |
| LCL | 288,503 | 5,229 | 0,669 | 4,646 | 16,167 |

**Calculating Interval Values**

The interval value is divided into 2 parts, first the bottom interval value with a score of 0 - 3, and the second the top interval value with a score of 3 - 7. For the score score 0 - 3 use the equation (UCL-LCL) / 3, and for score score 3 - 7 uses the equation (UCL-LCL) / 7. So that the value is as follows:

**Table 4: Interval Values**

| Interval | Ratio 1 | Ratio 2 | Ratio 3 | Ratio 4 | Ratio 5 | Ratio 6 |
|---|---|---|---|---|---|---|
| 0 - 3 | 0,012 | 43,813 | 0,400 | 0,038 | 0,995 | 7,729 |
| 3 - 10 | 0,005 | 18,777 | 0,172 | 0,016 | 0,426 | 3,312 |

**Calculating Weight Value**

Weight values are calculated based on criteria that have been previously determined by using AHP weights, will be obtained as follows.

**Table 5: Criteria Values**

| | Criteria 1 | Criteria 2 | Criteria 3 | Criteria 4 | Criteria 5 | Criteria 6 |
|---|---|---|---|---|---|---|
| Criteria 1 | 1 | 5 | 5 | 7 | 1 | 2 |
| Criteria 2 | 1/5 | 1 | 2 | 1 | 5 | 1 |
| Criteria 3 | 1/5 | 1/2 | 1 | 1 | 1 | 1 |
| Criteria 4 | 1/7 | 1 | 1 | 1 | 1 | 1 |
| Criteria 5 | 1 | 1/5 | 1 | 1 | 1 | 1 |
| Criteria 6 | 1/2 | 1 | 1 | 1 | 1 | 1 |

From the value of these criteria, we calculate the weight value.

**Table 6: Criteria Value After Calculation**

| | Criteria 1 | Criteria 2 | Criteria 3 | Criteria 4 | Criteria 5 | Criteria 6 |
|---|---|---|---|---|---|---|
| Criteria 1 | 0,329 | 0,575 | 0,455 | 0,583 | 0,100 | 0,286 |
| Criteria 2 | 0,066 | 0,115 | 0,182 | 0,083 | 0,500 | 0,143 |
| Criteria 3 | 0,066 | 0,057 | 0,091 | 0,083 | 0,100 | 0,143 |
| Criteria 4 | 0,047 | 0,115 | 0,091 | 0,083 | 0,100 | 0,143 |
| Criteria 5 | 0,329 | 0,023 | 0,091 | 0,083 | 0,100 | 0,143 |
| Criteria 6 | 0,164 | 0,115 | 0,091 | 0,083 | 0,100 | 0,143 |

The weight values for each criteria like this

**Criteria 1:** (0,329+0,575+0,455+0,583+0,100+0,286)/6 = 0,388(38,8%)

**Criteria 2:** (0,066+0,115+0,182+0,083+0,500+0,143)/6 = 0,181(18,8%)

**Criteria 3:** (0,066+0,057+0,091+0,083+0,100+0,143)/6 = 0,090(9%)

**Criteria 4:** (0,047+0,115+0,091+0,083+0,100+0,143)/6 = 0,096(9,6%)

**Criteria 5:** (0,329+0,023+0,091+0,083+0,100+0,143)/6 = 0,128(12,8%)

**Criteri 6:** (0,164+0,115+0,091+0,083+0,100+0,143)/6 = 0,116(11,6%)

**Calculating Performance Value and Productivity Index**

Performance scale is divided into 3 levels, it's: level 0 is the lowest value ratio, level 3 is the standard level or the average value of the ratio, and level 10 is the target to be achieved. Weight values are placed on the weight(%) line for each productivity criterion. The performance in January can be seen below.

**Table 7: Performance in January**

| Ratio 1 | Ratio 2 | Ratio 3 | Ratio 4 | Ratio 5 | Ratio 6 | Ratio |
|---|---|---|---|---|---|---|
| 0,047 | 367,480 | 6,090 | 0,911 | 8,270 | 22,929 | Performance |
| 0,030 | 551,381 | 7,631 | 0,899 | 10,613 | 62,540 | 10 |
| 0,035 | 532,604 | 7,459 | 0,883 | 10,187 | 59,227 | 9 |
| 0,040 | 513,827 | 7,288 | 0,866 | 9,761 | 55,915 | 8 |
| 0,046 | 495,050 | 7,116 | 0,850 | 9,335 | 52,603 | 7 |
| 0,051 | 476,273 | 6,944 | 0,833 | 8,908 | 49,290 | 6 |
| 0,056 | 457,496 | 6,773 | 0,817 | 8,482 | 45,978 | 5 |
| 0,062 | 438,719 | 6,601 | 0,800 | 8,056 | 42,666 | 4 |
| 0,067 | 419,942 | 6,430 | 0,784 | 7,630 | 39,353 | 3 |
| 0,079 | 376,129 | 6,029 | 0,746 | 6,635 | 31,625 | 2 |
| 0,092 | 332,316 | 5,629 | 0,707 | 5,640 | 23,896 | 1 |
| 0,104 | 288,503 | 5,229 | 0,669 | 4,646 | 16,167 | 0 |
| 7 | 1 | 2 | 10 | 4 | 0 | Score |
| 38,782 | 18,145 | 9,005 | 9,650 | 12,812 | 11,606 | Weight |
| 271,477 | 18,145 | 18,010 | 96,498 | 51,248 | 0,000 | Value |
| | | | | | | Performance Indicator |
| | | | | | | 455,38 |

To calculate the productivity index (IP), we used an equation like this

$$IP = \frac{currentindicatorperformance - 300}{300} x\ 100\%$$

From the equation, the productivity index value we get like this.

**Table 8: Productivity Index**

| Month | Performance Indicator | Basic Periode | Productivity index |
|---|---|---|---|
| January | 455 | 300 | 0,52 |
| February | 512 | 300 | 0,71 |
| March | 449 | 300 | 0,50 |
| April | 373 | 300 | 0,24 |
| May | 348 | 300 | 0,16 |
| June | 293 | 300 | -0,02 |
| July | 418 | 300 | 0,39 |
| August | 469 | 300 | 0,56 |
| September | 519 | 300 | 0,73 |
| Ocotober | 309 | 300 | 0,03 |
| November | 196 | 300 | -0,35 |
| December | 111 | 300 | -0,63 |

**Determining Low Performance Criteria**

We use traffic light systems to find criteria that cause low productivity, with this method we can see which criteria are influential or cause productivity to be low. Below this is the ratio value that is processed using TLS with the following conditions.

**Table 9: TLSRange**

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 < Green < 10 | 0,030 - 0,046 | 495,050 - 551,381 | 7,116 - 7,631 | 0,850 - 0,899 | 9,335 - 10,613 | 52,603 - 62,540 |
| 3 < Yellow < 6 | 0,051 - 0,067 | 419,942 - 476,273 | 6,430 - 6,944 | 0,784 - 0,833 | 7,630 - 8,908 | 39,353 - 49,290 |
| 0 < Red < 2 | 0,079 - 0,104 | 288,503 - 376,129 | 5,229 - 6,029 | 0,669 - 0,746 | 4,646 - 6,635 | 16,167 - 31,625 |

From the range of the table above, we can specify each ratio as in the table below.

**Table10: Traffic Light System**

| Month | Ratio 1 | Ratio 2 | Ratio 3 | Ratio 4 | Ratio 5 | Ratio 6 |
|---|---|---|---|---|---|---|
| January | 0,047 | 367,480 | 6,090 | 0,911 | 8,270 | 22,929 |
| February | 0,052 | 437,373 | 6,898 | 0,776 | 9,893 | 46,400 |
| March | 0,048 | 420,956 | 5,971 | 0,867 | 6,744 | 28,423 |
| April | 0,078 | 467,826 | 6,215 | 0,770 | 6,610 | 76,500 |
| May | 0,056 | 459,978 | 6,216 | 0,737 | 5,666 | 36,455 |
| June | 0,060 | 385,575 | 5,558 | 0,699 | 6,281 | 26,727 |
| July | 0,061 | 432,128 | 5,972 | 0,747 | 6,835 | 87,667 |
| August | 0,075 | 505,525 | 7,130 | 0,797 | 8,796 | 52,438 |
| September | 0,064 | 505,750 | 7,564 | 0,798 | 9,650 | 27,962 |
| Ocotober | 0,066 | 421,514 | 7,106 | 0,741 | 5,713 | 34,957 |
| November | 0,084 | 359,956 | 6,355 | 0,778 | 8,451 | 25,161 |
| December | 0,113 | 275,239 | 6,083 | 0,789 | 8,644 | 6,625 |

From the table above, we can see the criteria that have a sub-standard value given the identity in red, while the values entered in the standard are colored yellow, and the values that are above the standard or in accordance with the expectations of the company are being colored green.

## CONCLUSIONS

This study was conducted to look for the factors that cause low productivity, and to look for the factors that cause low productivity, we do productivity measurements using the OMAX method and from the results of the research, we can see in the form of graphs, the condition of company productivity when carried out measurements.

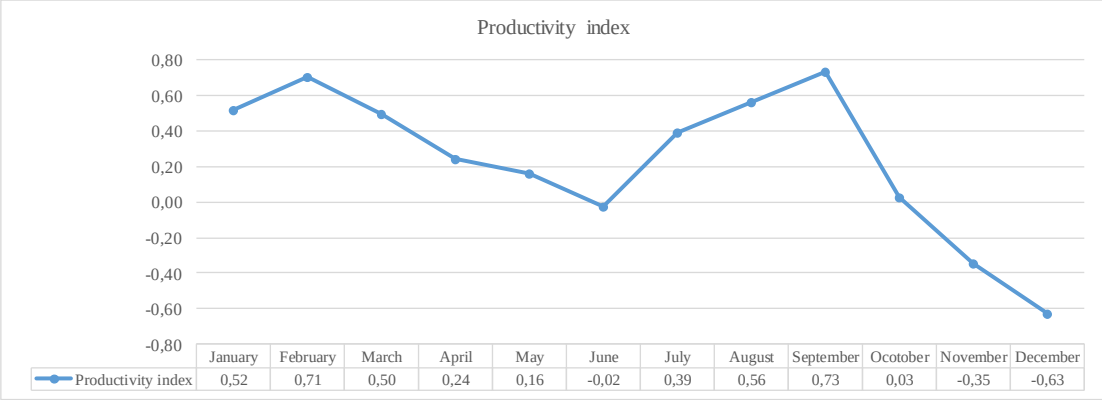
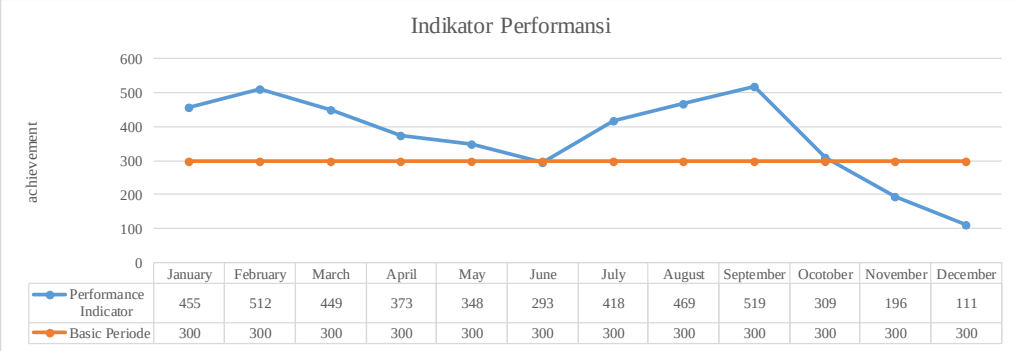



**Figure 1: Productivity Index**

While for one-year performance index can be seen in the following graph.




| | January | February | March | April | May | June | July | August | September | Ocotober | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Performance Indicator | 455 | 512 | 449 | 373 | 348 | 293 | 418 | 469 | 519 | 309 | 196 | 111 |
| Basic Periode | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 | 300 |

**Figure 2: Index Performance 2017**

In this study, it is known that in 2017, there were three times the productivity that is below the standard, it's on June (-0.02), November 9-0.35), and December (-063), so that it is necessary to take corrective steps. And, the factors that cause low productivity are as follows.

- The effectiveness of employee attendance, this criterion occupies the number one position, because of the high level of employee absence.
- Optimization of production machinery, this criterion occupies the number two position as a factor, that causes low productivity. This is due to high engine downtime.
- Criteria for minimizing of defective products, efficiency of working hours, electricity efficiency and optimization of production plans, each have the same effect on productivity, where these criteria have problems every month.

And, if we list the criteria that cause low productivity, it is as follows.

**Table 11:Causes of Low Productivity**

| Criteria | Total |
|---|---|
| ratio 6 - Effectiveness of employee attendance | 6 |
| ratio 5 - Optimization of production machinery | 4 |
| ratio 1 - Minimization of defective products | 3 |
| ratio 2 - Efficiency of working hours | 3 |
| ratio 3 - Efficient electricity usage | 3 |
| ratio 4 - Optimization of production plans | 3 |

From this research and in accordance with the conclusions obtained, there are several things that become recommendations for improvement. The things that become the priority of these improvements are,

- Control of attendance; attendance of employees has a very large influence on productivity, therefore it is necessary to do good control by management in terms of monitoring attendance, and it is necessary to arrange holiday time arrangements for employees that are tailored to the company's production needs.
- Maintenance of machines; machine downtime has a considerable influence on productivity, so that the need for preventive maintenance of the production machine is better and scheduled, and needs to be done to control the supply of components that often experience damage, so that the repair process can be done quickly.

- Management needs to be directly involved in controlling the production process, so that any problems in production can be dealt with quickly, and management also needs to control the use of resources in production, so that production can run efficiently and productively.

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